ATS Algae as a Soil Amendment Fertilizer

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Abstract

Several kinds of algal-based ecotechnologies are being studied for removing nutrients and sediments from polluted waters. Algae take up the pollutants through multiple mechanisms, and water quality is improved when the algal biomass is harvested. One of the benefits of this approach is that the harvested biomass is a byproduct of the water quality function and can be used in an economic process. In this study, data are reported on potential use of harvested algae to make a fertilizer. Building on earlier studies algae of known nutrient content that had been harvested from an algal turf scrubber in the Chesapeake Bay watershed, algae were added to potting soil in a plant growth experiment. The mass of algae added to the soil was scaled so that the amount of nitrogen added would be equivalent to the recommended commercial fertilizer application rate. Cucumber seeds were planted in the potting soil and their germination and growth were compared between pots with algae fertilizer versus pots with a commercial fertilizer. Rates of plant growth were similar between the two treatments demonstrating the byproduct value of the algae as a fertilizer. Since the algae harvested from the algal turf scrubber contain some of the fertilizer nutrients that had runoff from farm fields, their return use to farms as a fertilizer can help to close the agricultural nutrient cycle in the Chesapeake Bay watershed.

Introduction

- **Nutrient loading** into water bodies is rapidly becoming a top concern around the world.
- There are many reasons why sediments and nutrients arrive at water bodies, but a large portion of this loading can be traced back to **human activities**.
- The **Algal Turf Scrubber (ATS)** is an engineered water treatment system that removes nutrients from a water source via algae production.
- ATS systems have **simple designs** which can be much **less costly** than other methods of treatment. For an ATS to perform efficiently, the growing **algae must periodically be harvested** from the system.
- Recently, research has been done that analyzes the suitability of this **algae as a fertilizer**.
- Using harvested algae as fertilizer could be very beneficial for farmers because they can use this algae at a very low price. Using algae as fertilizer can **help the overall health of the water body** and the environment.
- Using this algae eliminates pollutants thus creating a **closed cycle**.

Figure 1 (above): Cucumber growing in grow chamber under LED lights.

Figure 2 (right): Cucumber seeds in separated vials by treatment for percent germination.

Methods

- **Experiment 1**: fertilizer application in triplicate for each treatment in 6 inch pots with 80 grams of potting soil.
  - **Treatment 1 & 2**: contained commercial fertilizer "high" and "low" Espoma Garden-Tone 4-6-6.
  - **Treatments 3, 4, & 5**: Equal nutrient amounts of ground freshwater algae (~0.5 ppt of salt) from the Susquehanna River were added in "high" "medium" and "low".
  - **Treatment 6**: A control with no added nutrients was tested.
- **Experiment 2:** same as above, but algae treatment with brackish water algae (8.0-12.0 ppt of salt) from the Port of Baltimore. Five treatments, with only "low" and "high" algae amendment added.
- The plant used in the experiment was **cucumber (*Cucumis sativus*)**, which has a maturity of approximately 50-70 days. Over this period, the cucumbers were grown indoors in the Animal Science Building at the University of Maryland. The cucumber was kept at room temperature, under LED plant grow lights. During the both trials, five seeds were planted 1 inch deep and 1.5 inches from the center of each pot to ensure germination. After about 4 weeks of the first trial, the cucumbers were harvested and plant height and mass were measured for analysis.
- **Metrics:** percent germination and biomass of above ground plant.

Nutrients added (g)	Control	Fertilizer Low	Fertilizer High	Algae Low	Algae Medium	Algae High
Trial 1	0.0	1.7	3.3	6.3	12.4	24.0
Trial 2	0.0	1.7	3.3	5.9	-	23.1

Table 1: Treatments broken down my nutrients added in grams (g) for two different experiments.

Results

- **Mean plant biomass:**
  - High fertilizer plant group: 0.07g. Low fertilizer group: 0.09g.
  - Low algae plant group: 0.09g. Medium algae plant group: 0.16g. High algae plant group: 0.16g.
- A **t-test** ran on the **algae high and fertilizer high** groups resulted in **a p-value of 0.092**, which **supported the null hypothesis** of no difference in plant growth between algae and commercial fertilizer.
- A **t-test** for the **low algae and low fertilizer** groups resulted in **a p-value of 0.060**, which also **supported the null hypothesis**.

Figure 3: Cucumber plants from Trial 1 ordered by treatment before cutting, drying, and weighing at week 4. Treatments from left to right in triplicate: Control, Algae high, Algae medium, Algae low, Fertilizer high, Fertilizer low.

Discussion

- Our results show that the **ATS biomass as a soil amendment provides an equal amount of nutrients to seedlings as commercial fertilizer** does when growing plants in potted soil.
- The two nutrient sources increased plant yield at about the same rate
- These results suggest that **ATS biomass could be used as a fertilizer substitute** when considering the environmental implications of commercial fertilizer and the high costs of eco-technology to remove excess nutrients from bodies of water.
- Other factors: which ATS biomass **(brackish vs. freshwater)**? At what scale?
- Although our experiment took place in a small-scale laboratory setting, the results suggest the **potential use of ATS biomass in larger scale agricultural systems, thus closing the open fertilizer system and reducing the need for excess nutrients in fertilizers**, while simultaneously saving money on highly expensive eco-technologies to clean water bodies.
- Further experiments with longer time periods could be done to explore plant and/or fruit quality compared to commercially grown fertilizers

References

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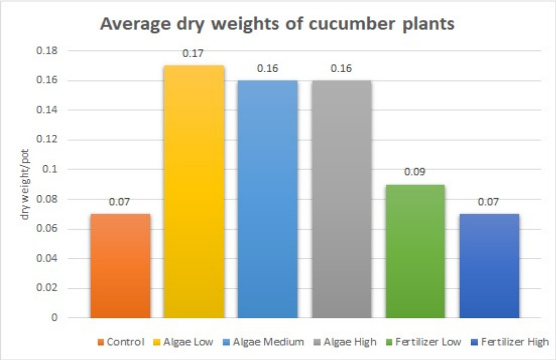

Figure 4: Average dry biomass of cucumber plants (dry weight per pot) frown with various treatments .